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Obikane

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(54) **VIDEO TRANSMISSION DEVICE AND ITS METHOD**

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(73) Assignee: **Sony Corporation**, Tokyo (JP)

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(51) **Int. Cl.**[7] **H04N 7/12**

(52) **U.S. Cl.** **375/240.28**; 348/500

(58) **Field of Search** 386/125, 126, 386/95, 109; 375/240.28; 348/500, 505, 521, 545, 547, 467, 466, 390, 461, 423.1; 370/389, 401, 468, 498; H04N 7/12

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,517,250	A *	5/1996	Hoogenboom et al.	348/467
5,621,840	A *	4/1997	Kawamura et al.	386/68
5,732,185	A *	3/1998	Hirayama et al.	386/70
5,856,973	A *	1/1999	Thomson	370/389
5,884,004	A *	3/1999	Sato et al.	386/98

* cited by examiner

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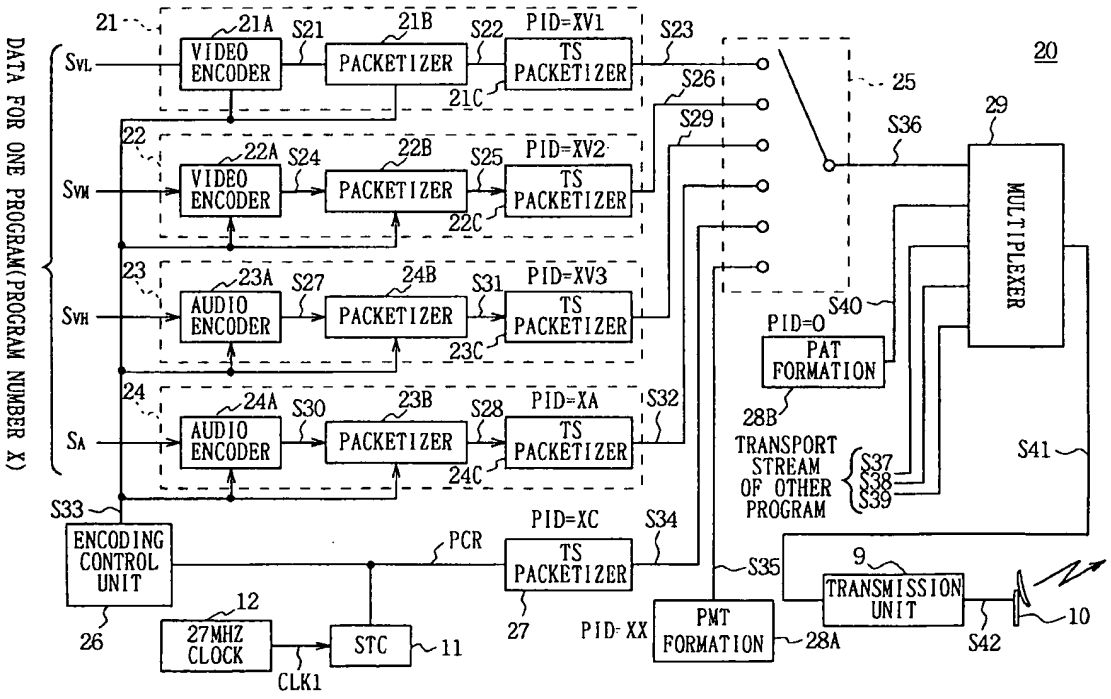
(74) *Attorney, Agent, or Firm*—Frommer Lawrence & Haug LLP; William S. Frommer

(57) **ABSTRACT**

In a video transmission device, a plurality of video data associated with one program can be transmitted without a complicated processing at the time of reception. In the case of transmitting a plurality of associated video data, first program information to control the plurality of associated video data as one program is formed and transmitted, so that the plurality of video data associated with one program can be transmitted without a complicated processing.

8 Claims, 10 Drawing Sheets



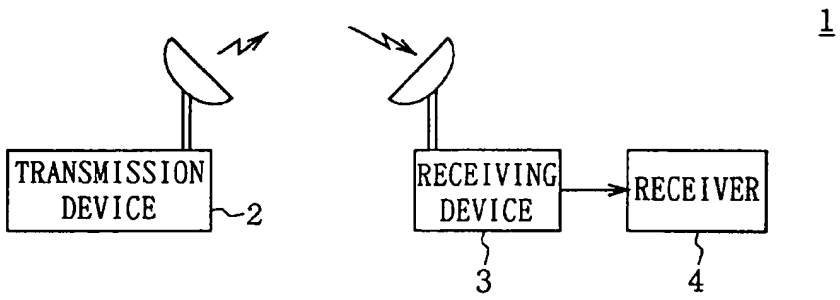


FIG. 1(RELATED ART)

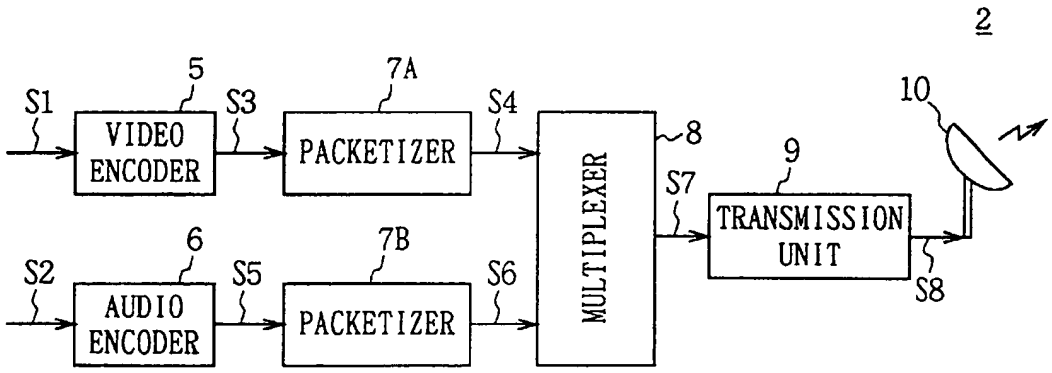


FIG. 2(RELATED ART)

FIG. 3A
(RELATED ART)

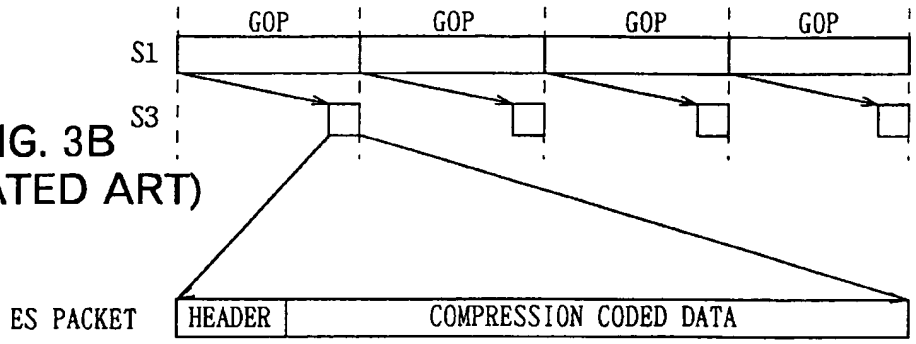


FIG. 3B
(RELATED ART)

FIG. 4A
(RELATED ART)

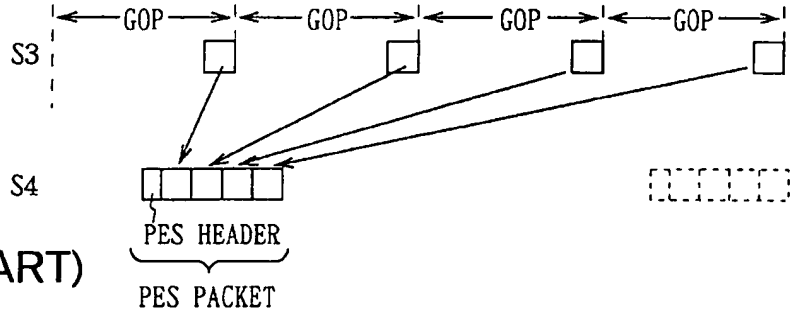


FIG. 4B
(RELATED ART)

FIG. 5A(RELATED ART)

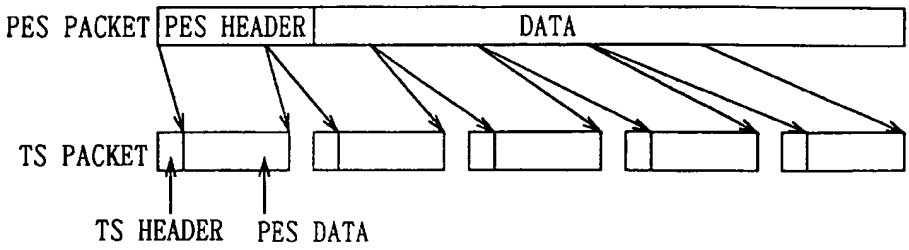


FIG. 5B(RELATED ART)

FIG. 6A(RELATED ART)

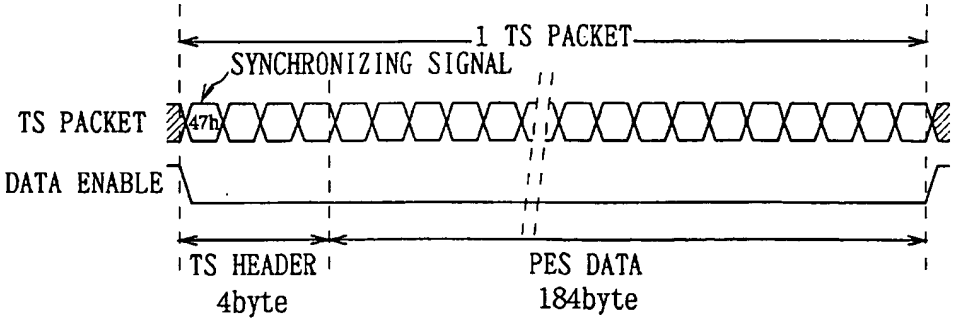


FIG. 6B(RELATED ART)

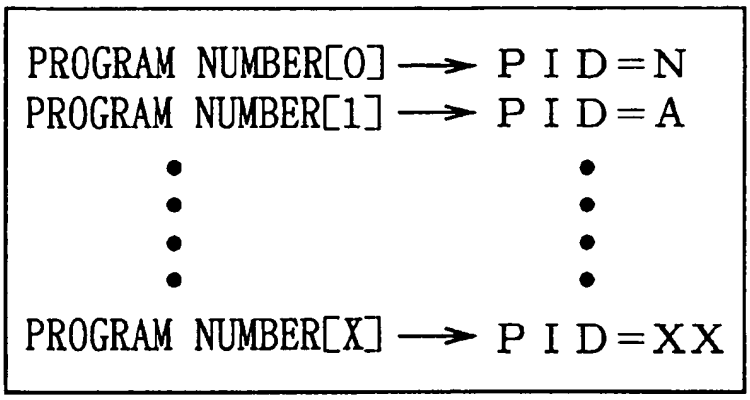


FIG. 7(RELATED ART)

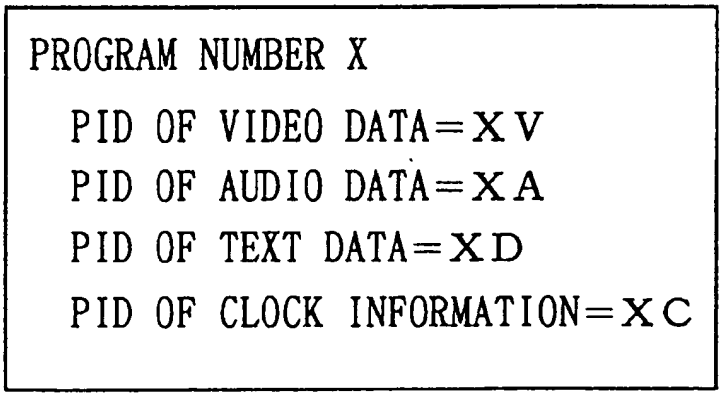


FIG. 8(RELATED ART)

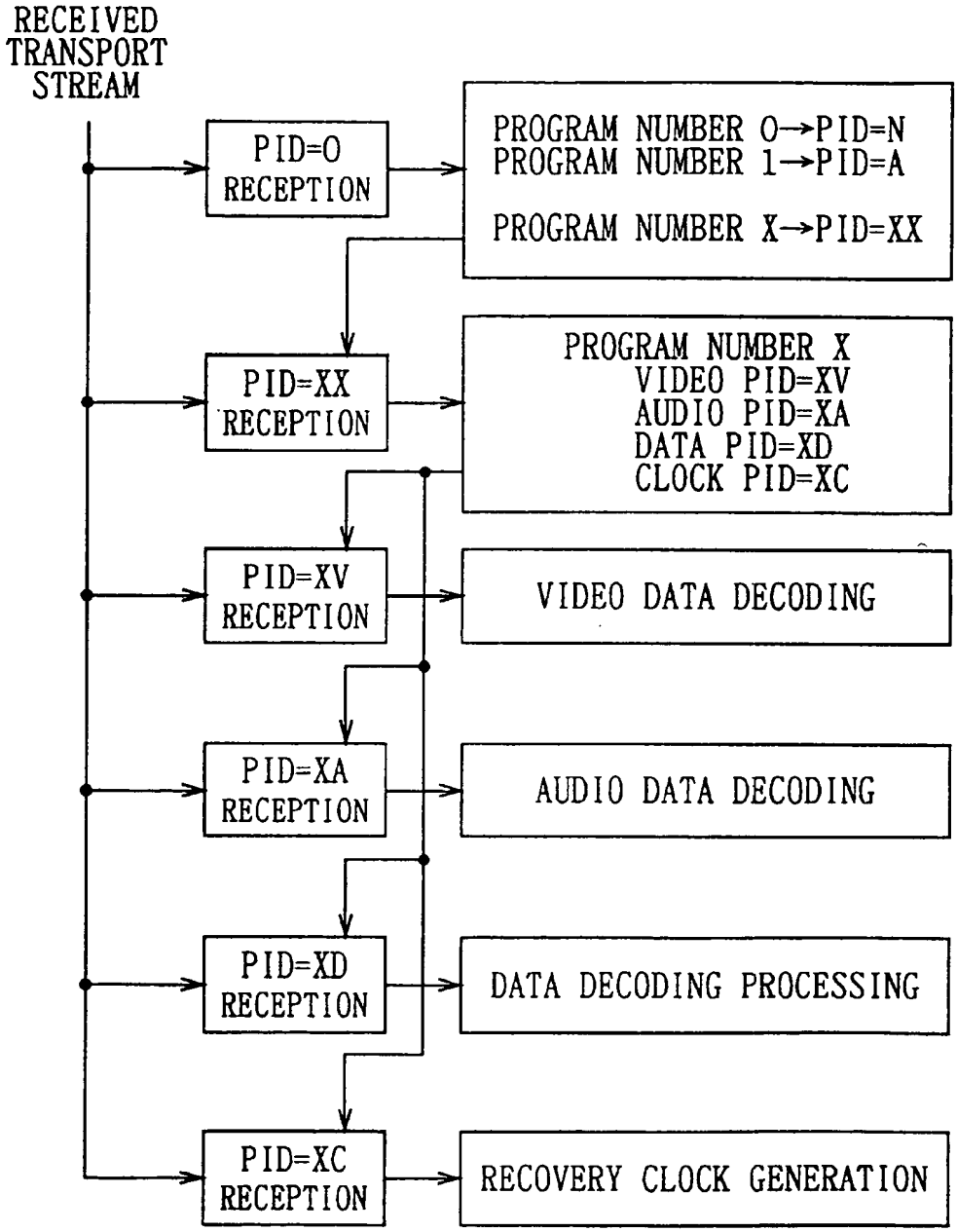


FIG. 9(RELATED ART)

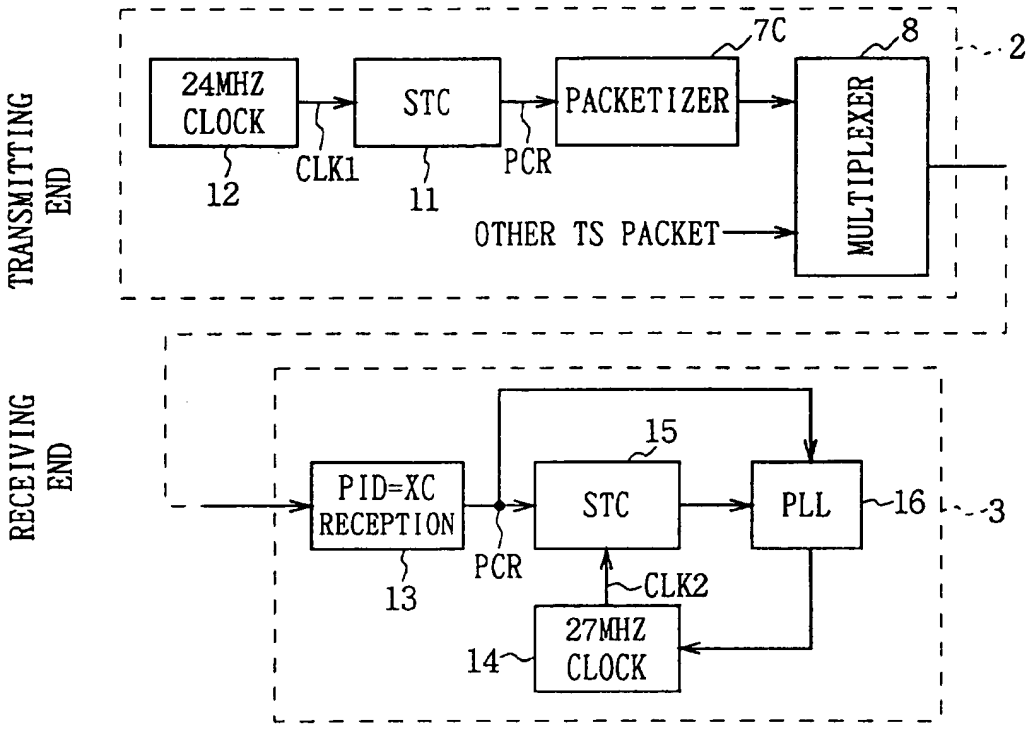


FIG. 10(RELATED ART)

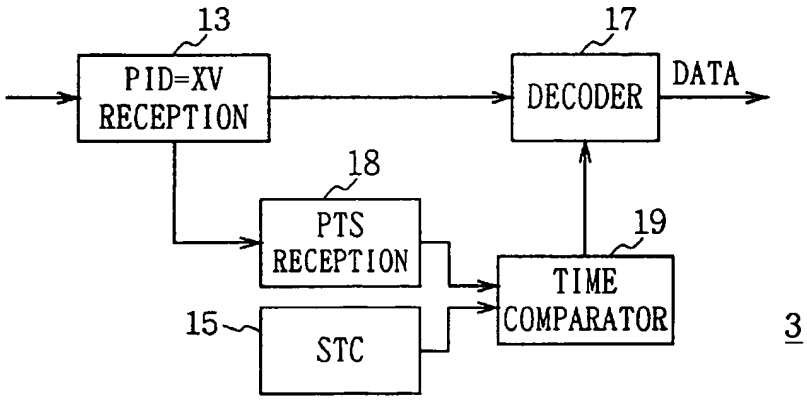


FIG. 11(RELATED ART)

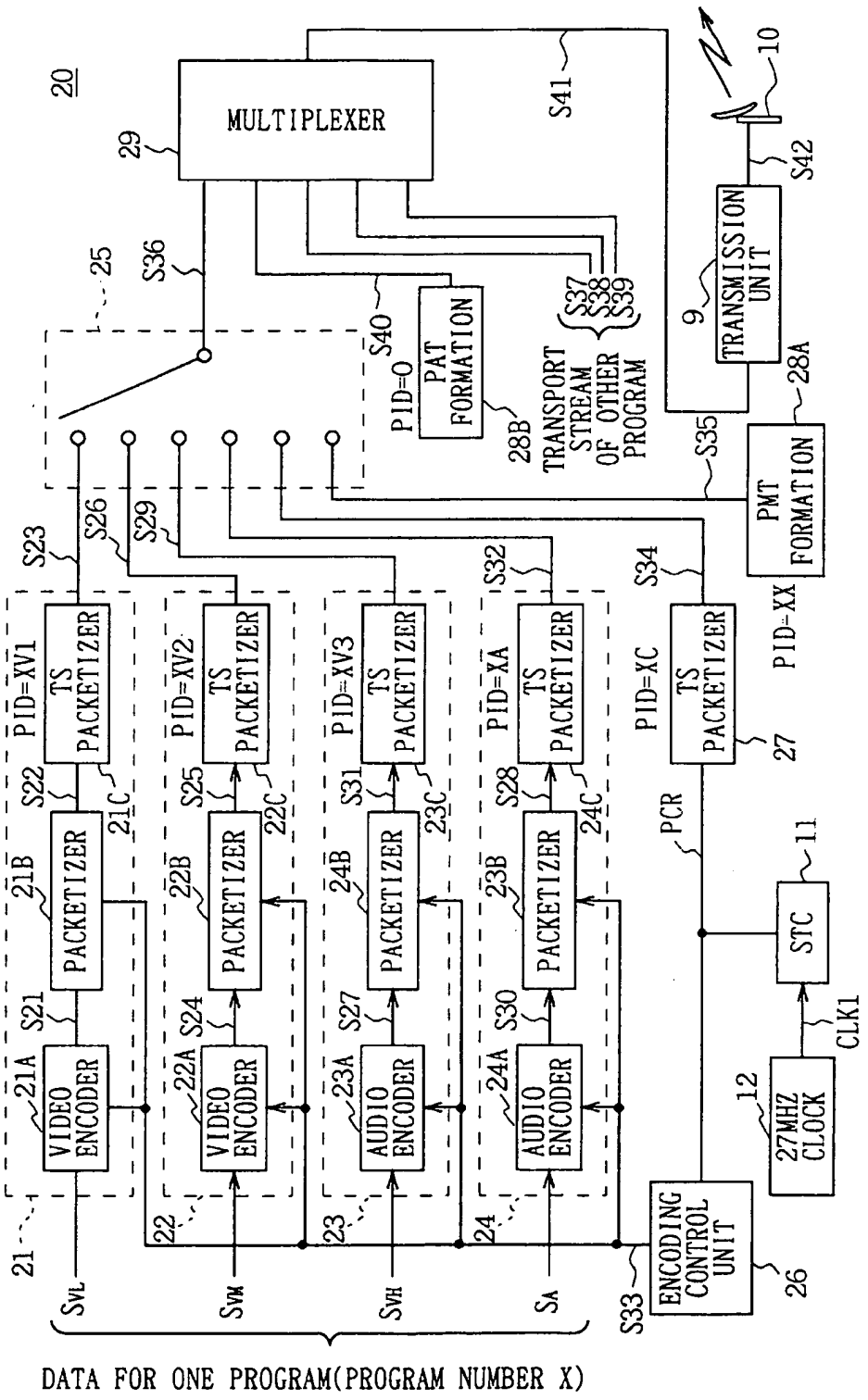

20
MULTIPLEXER
29
S41
10
S42
TRANSMISSION UNIT
9
28A
PMT FORMATION
S35
PID=XX
25
S36
S40
PID=0
PAT FORMATION
28B
S37
S38
S39
TRANSPORT STREAM OF OTHER PROGRAM
S23
S26
S29
S32
S34
PID=XV1
PID=XV2
PID=XV3
PID=XA
PID=XC
TS PACKETIZER
TS PACKETIZER
TS PACKETIZER
TS PACKETIZER
TS PACKETIZER
27
S22
S25
S31
S28
21C
22C
23C
24C
PACKETIZER
PACKETIZER
PACKETIZER
PACKETIZER
21B
22B
23B
24B
PCR
STC
11
S21
S24
S27
S30
VIDEO ENCODER
VIDEO ENCODER
AUDIO ENCODER
AUDIO ENCODER
21A
22A
23A
24A
CLK1
12
27MHZ CLOCK
21
22
23
24
SVL
SVM
SVH
SA
S33
ENCODING CONTROL UNIT
26
DATA FOR ONE PROGRAM(PROGRAM NUMBER X)

FIG. 12

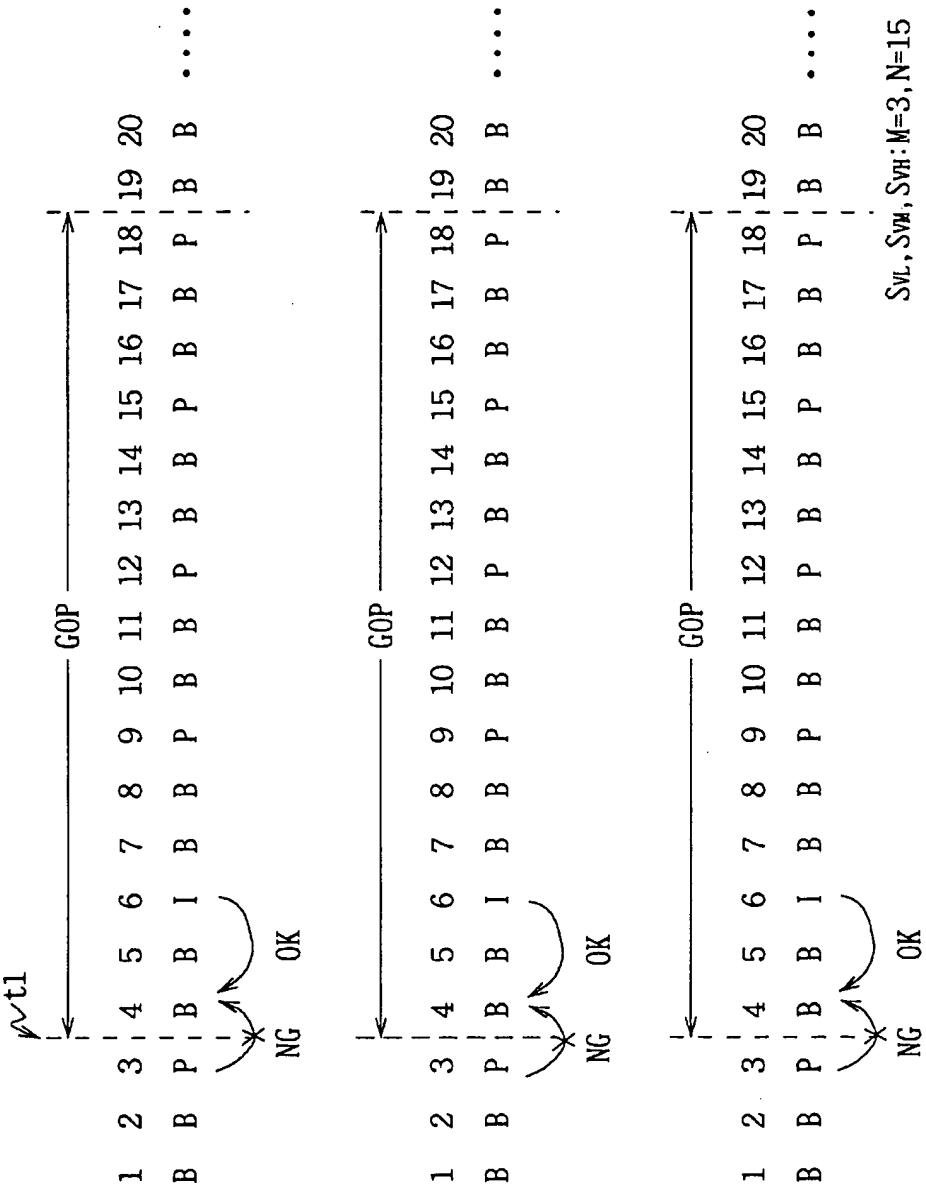


FIG. 13A

FIG. 13B

FIG. 13C

PROGRAM NUMBER X

PID OF LOW ANGLE VIDEO DATA = XV1
PID OF MIDDLE ANGLE VIDEO DATA = XV2
PID OF HIGH ANGLE VIDEO DATA = XV3
PID OF AUDIO DATA = XA
PID OF CLOCK INFORMATION = XC

FIG. 14

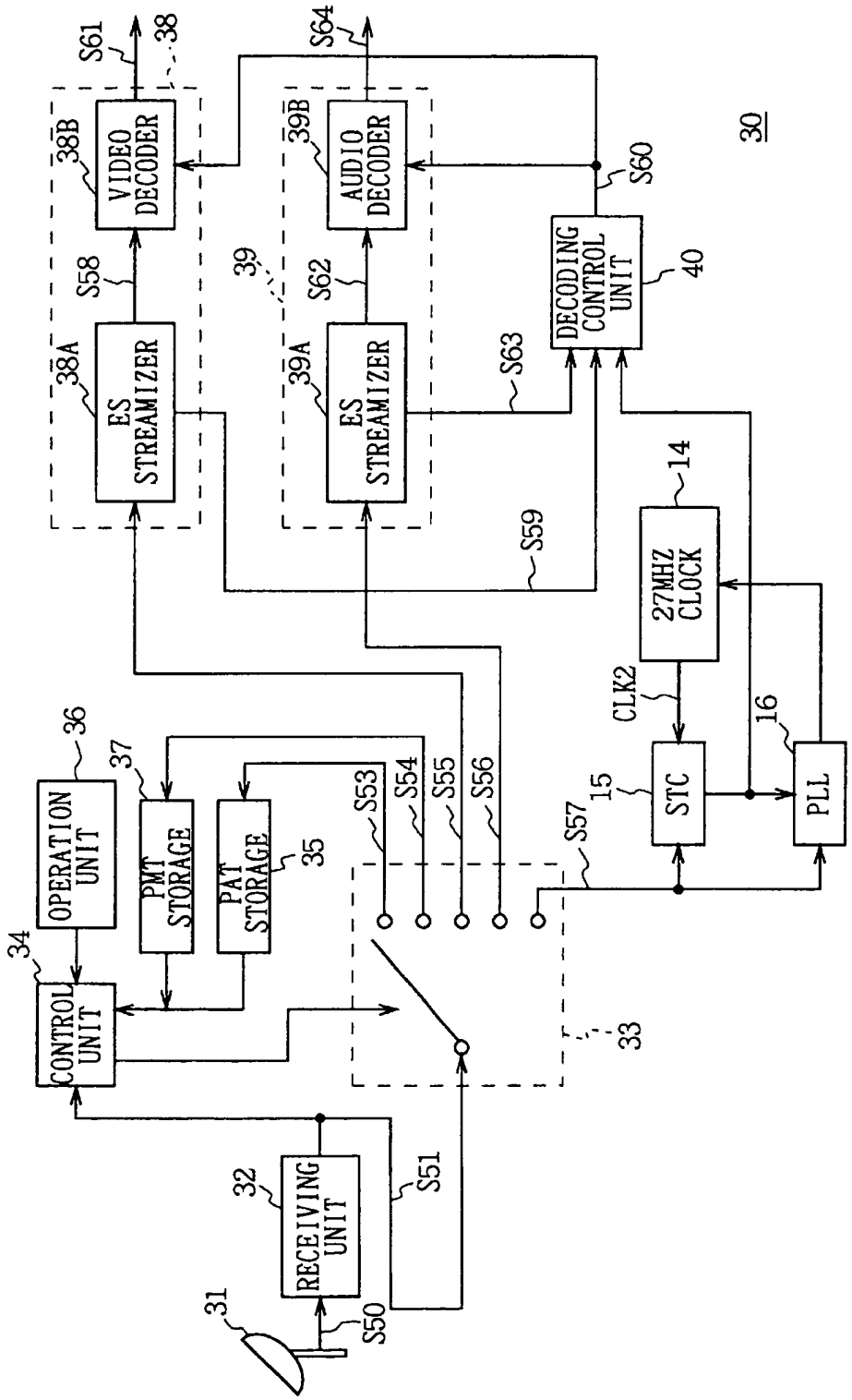

30
31
32
RECEIVING UNIT
33
34
CONTROL UNIT
35
PAT STORAGE
36
OPERATION UNIT
37
PMT STORAGE
38
38A
ES STREAMIZER
38B
VIDEO DECODER
39
39A
ES STREAMIZER
39B
AUDIO DECODER
40
DECODING CONTROL UNIT
14
27MHZ CLOCK
15
STC
16
PLL
CLK2
S50
S51
S53
S54
S55
S56
S57
S58
S59
S60
S61
S62
S63
S64

FIG. 15

VIDEO TRANSMISSION DEVICE AND ITS METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a video transmission device and its method and more particularly, is suitably applied to a digital broadcasting system.

2. Description of the Related Art

A digital broadcasting system for multiplexing coded video and audio data to transmitting them through a satellite circuit has been proposed and become practical use. In this digital system, video data and also audio data are encoded, and by packetizing and multiplexing the coded video and audio data per fixed data unit, transport data (hereinafter, referred to as a transport stream) is formed and transmitted through such as a satellite wireless circuit.

Here, the digital broadcasting system will be described with reference to FIG. 1. As shown in FIG. **1**, a digital broadcasting system **1** is roughly comprised of a transmission device **2** to be set in a broadcasting station, a receiving device **3** and a television receiver **4** to be installed in each house. Transport stream data to be transmitted from the transmission device **2** is received by the receiving device **3**, and by sending out this to the television receiver **4**, broadcasting video and audio can be watched.

As shown in FIG. **2**, in the transmission device **2**, firstly, video data **S1** to be transmitted is entered into a video encoder **5**, and audio data S2 accompanying with the video data SI is entered into an audio encoder **6**. The video encoder **5** successively encodes the entered video data S1 based on the MPEG2 video encoding system described in the International Standards Regulation ITU-T Recommendation H.262 ISO/IEC13818-2, and outputs a stream of the resulting coded video data S3 (generally, this is called as an elementary stream (ES)) to a packetizer **7A**. In the case of encoding the video data **S1**, the video encoder **5** applies an encoding processing with video data for several pictures, which are called as group of picture (GOP), as a coding unit, and by adding a header consisting of each parameter information at the time of encoding to the head of the coded video data, forms coded video data S3. Thus, a decoding processing can be conducted based on the parameter information of the header at the time of decoding.

As shown in FIGS. **3A** and **3B**, the packetizer **7A**, by connecting a fixed number of ES packets of coded video data S3 encoded per GOP and adding a packetized elementary stream (PES) header to the head of the packet, PES-packets the coded video data S3 and outputs the PES-packetized coded video data S4 to a multiplexer **8**. Note that, data of the PES header consist of time information when reproducing and outputting the video data included in the PES packet at the receiving side (generally, called as presentation time stamp (PTS)), identification information showing the type of elementary stream included in the PES packet (generally, called as a stream ID), and the like. In this connection, such time information PTS is provided in the PES header, so that audio and video can be synchronized and reproduced at the receiving side.

On the other hand, the audio encoder **6** encodes the input audio data S2 based on an audio encoding system described in the International Standards Regulation ITU-T Recommendation H.262 ISO/IEC13181-3 and outputs the resultant coded audio data S5 to a packetizer **7B**. Note that, the audio encoder **6** encodes the audio data S2 per fixed number of samples called as an audio frame in the same manner as in the case of video data shown in FIG. **2**, and by adding a header comprising parameter information at the time of encoding to the head of the coded audio data, forms an ES-packetized coded audio data **S5**.

Moreover, the packetizer **7B**, by connecting a fixed number of ES packets of the coded audio data **S5** encoded per audio frame and adding the PES header to the head of the packet, PES-packetizes the coded audio data **S5** and outputs the PES-packetized coded audio data **S6** to the multiplexer **8**. The data of the PES header are approximately the same as in the case of video.

The multiplexer **8** transport-stream (TS)-packetizes the PES-packetized coded video data **S4** and coded audio data **S6** by dividing them per fixed data unit respectively, and by switching and outputting the TS packets of the video and audio at established intervals, multiplexes them to form a transport stream **S7**.

More specifically, as shown in FIGS. **5A**, **5B**, **6A** and **6B**, the multiplexer **8**,,by dividing each PES packet of the coded video data **S4** and coded audio data **S6** per 184 bytes and adding a TS header of 4 bytes to each of their heads, forms a TS packet. In this case, the TS header is formed of synchronization information and packet identification information PID showing the type of data included in the TS packet. However, the data part of 184 bytes is not only comprised of PES data but in practice, also additional information is added and these additional information and PES data are adjusted to become 184 bytes altogether. Such data adjusting processing is generally called as a stuffing processing. In this connection, even when PES data are not enough, the stuffing processing is conducted so that data part becomes 184 bytes by adding dummy byte. Then, the multiplexer **8** forms a transport stream **S7** by multiplexing thus formed video TS packets onto thus formed audio TS packets.

In this connection, since proper packet identification information PID is added to the multiplexed video and audio TS packet per data, the receiving side can separate the TS packets based on the packet identification information PID to decode video and audio from one multiplexed transport stream.

Thus, the transport stream **S7** comprised of video and audio TS packets is transmitted to the succeeding transmission unit **9**. The transmission unit **9**, after forming a transmission signal by applying the modulation processing to the transport stream **S7** for transmitting, forms a transmission signal **S8** by applying a frequency conversion processing to the transmission signal of a stated band and transmits this toward the satellite (not shown) via an antenna **10**.

A transmission signal **S8** relayed via the satellite is received by the receiving device **3** shown in FIG. **1** and the receiving device **3** conducting a reverse processing of the transmission device **2**, so that the transmission signal **S8** is decoded to the original video and audio data. More specifically, the receiving device **3** applies the frequency conversion processing and demodulation processing to the received signal to restore the transport stream **S8** transmitted from the transmission device **2**. And then, the receiving device **3** separates video TS packets and audio TS packets based on the packet identification information PID and takes out coded video data and coded audio data from each TS packet separated, and applying the decoding processing to these data, restores video data and audio data transmitted. Thus, these restored video data and audio data are transmitted to the television receiver **4**, so that video and audio of the program sent from the transmitter **2** can be watched.

In the foregoing explanation, the transmission device **2** transmits video and audio data forming one program. However, in practice, the transmission device **2** transmits video and audio data of the plural number of programs in the form of one transport stream **S8** by TS-packetizing and multiplexing video and audio data of plural programs. Furthermore, in the case where text data are attached to the video data, the text data can also be transmitted in the form of one transport stream **S8** by being TS-packetized and multiplexed. In this connection, if the plural programs are multiplexed, the receiving side extracts TS packets of a desired program based on the packet identification information PID added to the TS packets and thus, the video and audio data of the desired program can be restored.

At this point, the processing in the case of multiplexing the plural programs will be described in detail in the following paragraphs. Since the receiving side extracts the TS packets of the desired program based on the packet identification information PID as described above, it is necessary to know the packet identification information PID added to the TS packet of video and audio data of each program. Accordingly, the transmission device **2** TS-packetizes the program information showing the packet identification information PID added to the TS packet of each program, and multiplexes and transmits them onto the video and audio TS packets.

In this case, the program information to be transmitted is formed hierarchically, and consists of program information of higher hierarchy called as program association table (PAT) and program information of lower hierarchy called as program map table (PMT). As shown in FIG. **7**, the higher hierarchy program information PAT is the information to show the packet identification information PID of TS packet in which the program information PMT formed per program is stored, that is, the information like a table of contents on the program information PMT. Referring to the program information PAT, it is possible to know in which TS packet the program information PMT of each program is stored. For example, it is clear that the program information PMT having the program number "0" is stored in the TS packet having the packet identification information PID "N". Note that, "0" is added to the TS packet storing the program information PAT as the packet identification information PID. Thus, the receiving side, extracting the TS packet whose packet identification information PID is "0" from the transport stream received and decoding it, can obtain the program information PAT.

On the other hand, as shown in FIG. **8**, the program information PMT is the information to show the packet identification information PID of TS packet in which each data forming the program is stored, per program and is the detailed program information formed per program. Accordingly, by referring to the program information PMT, it is possible to know in which TS packet each data forming the program is stored. For example, it is clear that the video data having the program number "X" is stored in the TS packet having the packet identification information PID "XV", and the audio data having the program number "X" is stored in the TS packet having the packet identification information PID "XA". Further, the text data having the program number "X" is stored in the TS packet having the packet identification information "XD", and the clock information having the program number "X" is stored in the TS packet having the packet identification information PID "XC".

At this point, an algorithm in the case of selecting a desired program in the receiving device **3** based on the program information PAT and PMT will be described below with reference to FIG. **9**. First, in the receiving device **3**, after turning the power source ON, the TS packet having the packet identification information PID "0" is extracted from the transport stream received to obtain the program information PAT. At this point, if a request to display the program having the program number "X" is entered by the user, the receiving device **3**, referring to this program information PAT, investigates the packet identification information PID of TS packet in which the program information PMT having the program number "X" is stored. In this case, since the TS packet in which the program information PMT having the program number "X" is stored has the packet identification information PID "XX", the receiving device **3** extracts the TS packet having the packet identification information PID "XX" from the transport stream received to obtain the program information PMT concerning the program number "X".

The receiving device **3**, by referring to the program information PMT obtained, can grasp the TS packet in which each data associated with the program number "X" is stored. Thus, the receiving device **3** obtains and decodes coded video data having the program number "X" by extracting the TS packet having the packet identification information PID "XV" from the transport stream received. Simultaneously, the receiving device **3**, by extracting the TS packet having the packet identification information PID "XA" from the transport stream, obtains and decodes the coded audio data having the program number "X". Moreover, in tandem with the video and audio decoding processing, the receiving device **3**, by extracting the TS packet having the packet identification information PID "XD" from the transport stream received, obtains and decodes text data on the program number "X". Simultaneously, by extracting the TS packet having the packet identification information PID "XC", the receiving device **3** obtains clock information on the program number "X" and generates a recovery clock to become the reference for decoding processing and display-output based on the clock information. In this connection, the recovery clock is necessary for decoding video data and audio data, in the strict sense, the generating processing of the recovery clock is to be started first.

Accordingly, the receiving device **3**, firstly, obtains the program information PAT which is equivalent to a table of contents, and then referring to the program information PAT, obtains the program information PMT showing the details of a program requested by a user and referring to the program information PMT, obtains coded video data and coded audio data concerning the requested program. With this arrangement, even in the case where multiple programs are multiplexed in one transport stream, the requested program can be reproduced and sent out.

At this point, the generating processing of recovery clock described above will be explained more concretely. The generating processing of the recovery clock is generally called as PCR recovery and is for recovering the clock used in the transmission device **2**, in the receiving device **3**. In the transmission device **2**, the encoding processing for video data and audio data are conducted in synchronism with 27 MHz clock. In the receiving device **3**, the same clock as the clock at the time of the encoding processing is reproduced and the decoding processing and the display-output are conducted at the timing specified by the transmission device **2**, in order to correctly reproduce video data and audio data without excess or lack of data.

Accordingly, in the digital broadcasting system **1**, clock synchronization is to be conducted by the processing

described as follows in the receiving side. As shown in FIG. **10**, a counter **11** called as a system time clock (STC) is provided in the transmission device **2**. This counter (STC) **11** is formed of 33-bit counter, and by conducting the counting operation with 27 MHz clock CLK1, which is generated in the clock generator **12** and becomes the reference clock for the encoding processing, can count 24 hours. In the transmission device **2**, making the count value of the counter (STC) **11** as clock information PCR, the packetizer **7**C TS-packetizes at a fixed cycle. The multiplexer **8** multiplexes and transmits the TS packet consisting the clock information PCR together with other TS packets such as video and audio. Note that, the packet identification information PID of the clock information to be regulated by the aforementioned program information PMT is added to the TS packet including the clock information PCR. Accordingly, the receiving device **3**, by referring to the program information PMT, can extract the TS packet in which the clock information PCR on that program is included.

The receiving device **3**, referring to the program information PMT described above, extracts the TS packet in which the clock information PCR is included. In the example shown in FIG. **8**, since the packet identification information PID of the clock information is "XC", the TS packet having the packet identification information PID "XC" is extracted by the demultiplexer **13**. The receiving device **3** has a counter (STC) **15** which conducts the counting operation at 27 MHz clock CLK2 generated in the clock generator **14**, and sets the clock information PCR included in the extracted TS packet to the counter (STC) **15** as an initial value, and makes the counter (STC) **15** to count operate based on the clock CLK2. Then, obtaining the difference between the clock information transmitted at a fixed cycle and the count value of the counter (STC) **15**, and by controlling the operation of the clock generator **14** by a phase locked loop (PLL) **16** based on the difference, the receiving device **3** forms a clock CLK2 of which phase and frequency completely conform with that of the clock CLK1 generated in the transmitting side. Thus, by transmitting the clock information PCR from the transmission device **2** and controlling the operation of the clock generator **14** based on the clock information PCR in the receiving device **3**, the clock CLK2 having the same frequency and phase as the transmitting side can be reproduced in the receiving device **3** and the operation of the counter (STC) **15** can be synchronized with the operation of the transmitting side.

In the transmission device **2** of the transmitting side, in the case of forming the PES packet, the time information PTS to regulate the timing of reproduction and output of video or audio data contained in the PES packet is added. And the decoding processing is conducted at the timing based on the time information PTS, in order to synchronize video and audio without excess or lack of data. Accordingly, the receiving device **3** takes out the time information PTS added when PES packetizing, from the TS packet received, compares the time information PTS to the value of its own counter (STC) **15**, and starts the decoding processing at the timing when these values coincide.

For example, in the case of decoding video data of the program in the example shown in FIG. **8**, firstly the demultiplexer **13** takes out the TS packet having the packet identification information PID "XV" from the transport stream received, and restores PES packet from the TS packet and transmits this to the decoder **17**, as shown in FIG. **11**. Moreover, the demultiplexer **13** transmits the PES packet to the PTS receiving unit **18**. The PTS receiving unit **18** extracts time information PTS from the PES packet and transmits this to a time comparator **19**. The count value of the counter (STC) **15** is also supplied into the time comparator **19**, and the time comparator **19** compares the count value of the counter (STC) **15** to the value of time information PTS supplied from the PTS receiving unit **18**. If these count values coincide, the timing information showing the decoding start timing is transmitted to the decoder **17**. With this arrangement, in the decoder **17**, by starting to decode the PES packet based on this timing information, the decoding processing can be conducted at the timing specified by the time information PTS and the video data can be output at the timing in synchronism with the audio data, the occurrence of excess or lack of data can be prevented.

Note that, in the case of video data, a horizontal synchronizing signal and a vertical synchronizing signal are needed when displaying video. These horizontal and vertical synchronizing signals are to be formed based on the timing relative to the time information PTS in the decoder **17**.

In the conventional digital broadcasting system **1** constructed as described above, video and audio data for multiple programs can be transmitted. However, as to each program, only one video data can be transmitted. Even in one program, if a plurality of video data associated with the program can be transmitted, it is considered that the usability of the digital broadcasting system can be further improved. For example, in the case where the program A is a concert program of a prescribed musician, if the low angle video data obtained by photographing the concert from the lower part, the middle angle video data obtained by photographing the concert from the front, and the high angle video data obtained by photographing the concert from the upper part can be transmitted as the video data of the program A, the user can select desired video data among the plurality of video data of the program A to view the program that fits to his taste. Thus, it is considered that the usability can be further improved.

In order to transmit a plurality of video data for one program, the conventional digital broadcasting system **1** treats the plurality of video data which are originally one program, as separate programs, and multiplexes and transmits them as the separate programs respectively. For example, if the video data of middle angle program A is transmitted as a program A, the video data of low angle program A is transmitted as a program B, and the video data of high angle program A is transmitted as a program C, desired video data can be selected according to the principle of program selection described above. However, if these were treated merely as the separate programs, when shifting the video data from middle angle to high angle video data, it is necessary to obtain the program information PMT whenever the video data are shifted because these are different programs. Therefore, the reception processing becomes complicated, and there is a possibility that it cannot be shifted to another video data immediately. Moreover, in the case where the plurality of data are treated as separate programs, programs cannot be synchronized with each other. Thus, there is a possibility that video data does not continue when the video data is shifted.

SUMMARY OF THE INVENTION

In view of the foregoing, an object of this invention is to provide a video transmission device and its method capable of transmitting a plurality of video data associated with one program without a complicated reception processing.

The foregoing object and other objects of the invention have been achieved by the provision of a video transmission

device and its method. In the present invention, a plurality of associated video data is encoded respectively and then, different packet identification information is added to each coded video data to packetize the coded video data. And in order to control the plurality of associated video data as one program, first program information to show the packet identification information added to coded video data respectively, per video data is formed, and proper packet identification information is added to the first program information to packetize the first program information. Then, by multiplexing packets concerning each video data and the first program information, first transmission data for one program is formed. Further, the first transmission data, the second transmission data formed of a different program, and second program information to show the packet identification information added to the first program information of each program to be transmitted, per program are multiplexed in order to form and transmit third transmission data through the predetermined circuit.

In this way, in the case of transmitting a plurality of associated video data, since the first program information for controlling the plurality of associated video data as one program is formed and transmitted, video data can be shifted without receiving program information whenever shifting video data, like the conventional case in which associated video data are transmitted as separate programs. Thus, the processing of the receiving side can be simplified.

The nature, principle and utility of the invention will become apparent from the following detailed description when read in conjunction with the accompanying drawings in which like parts are designated by like reference numerals or characters.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is a block diagram showing the construction of a digital broadcasting system;

FIG. **2** is a block diagram showing the construction of a conventional transmission device;

FIGS. **3**A and **3**B are schematic diagrams explaining the video data encoding;

FIGS. **4**A and **4**B are schematic diagrams explaining the video data PES packetization;

FIGS. **5**A and **5**B are brief linear diagrams explaining the TS packet forming method;

FIGS. **6**A and **6**B are timing charts showing the timing of TS packet;

FIG. **7** is a table explaining program information PAT;

FIG. **8** is a table explaining program information PMT;

FIG. **9** is a schematic diagram explaining an algorithm of program selection;

FIG. **10** is a block diagram explaining the clock recovery method in the receiving device;

FIG. **11** is a block diagram explaining the decoding timing control method in the receiving device;

FIG. **12** is a block diagram showing the construction of a transmission device of a digital broadcasting system according to the present invention;

FIGS. **13**A and **13**B are schematic diagrams explaining GOP sequence of each video data;

FIG. **14** is a schematic diagram showing program information PMT to be generated in the transmission device; and

FIG. **15** is a block diagram showing the construction of a receiving device.

DETAILED DESCRIPTION OF THE EMBODIMENT

Preferred embodiments of this invention will be described with reference to the accompanying drawings:

In FIG. **12**, **20** generally shows a transmission device of a digital broadcasting system according to the present invention, which is to transmit a plurality of associated video data S_{VL}, S_{VM} and S_{VH} as one program. More specifically, in the transmission device **20**, low angle video data S_{VL} obtained by photographing a concert by a prescribed musician from the lower part (hereinafter, referred to as first video data) is entered into a first video encoding unit **21**, and middle angle video data S_{VM} obtained by photographing the concert from the front (hereinafter, referred to as second video data) is entered into a second video encoding unit **22**, and high angle video data S_{VH} obtained by photographing the concert from the upper part (hereinafter, referred to as third video data) is entered into a third video encoding unit **23**, and audio data S_A accompanying the video data S_{VL}, S_{VM} or S_{VH} is entered into an audio encoder **24**.

In the first video encoding unit **21**, firstly the first video data S_{VL} supplied is entered into a video encoder **21**A. The video encoder **21**A successively compress-encodes the first video data S_{VL} based on the MPEG2 video encoding system described in the International Standards Regulation ITU-T Recommendation H.262 ISO/IEC13818-2, and outputs a stream of the resultant coded video data **S21** to a packetizer **21**B.

In this connection, the video encoder **21**A conducts the encoding processing with video data for several pictures which are called GOP as a coding unit in the case of encoding the first video data S_{VL}, similarly to the case shown in FIGS. **3**A and **3**B, and by adding a header consisting of each parameter information at the time of encoding to the head of the coded video data, forms coded video data **S21**.

The packetizer **21**B, similarly to the case shown in FIGS. **4**A and **4**B, connecting a fixed number of ES packets of the coded video data **S21** encoded per GOP and adding a PES header to its head, PES-packetizes the coded video data **S21** and outputs the PES-packetized coded video data **S22** to a TS packetizer **21**C. In this case, the PES header includes time information PTS for reproducing and outputting the video data at the receiving side.

The TS packetizer **21**C divides each PES packet of the coded video data **S22** per 184 bytes similar to the example shown in FIG. **5**, and forms a TS packets by adding a TS header of 4 bytes to each of their heads, and outputs a stream of the TS packets **S23** to a multiplexer **25** of the succeeding stage. Also in this case, the TS header is formed of synchronization information and packet identification information PID. In this connection, this TS packetizer **21**C, by adding the packet identification information PID whose value is "XV1" to the TS packet formed, shows the TS packet is associated with the first video data.

Similarly, in the second and the third video encoding units **22** and **23**, the second and the third video data S_{VM} and S_{VH} are encoded per GOP by video encoder **22**A and **23**A to form coded video data **S24** and **S27**, respectively. The coded video data **S24** and **S27** are PES-packetized by following TS packetizers **22**C and **23**B to form coded video data **S25** and **S28**, respectively. Then, the coded video data **S25** and **S28** are TS-packetized by following TS packetizers **22**C and **23**C respectively, and the resulting TS packet streams **S26** and **S29** are sent out to the multiplexer **25** of the succeeding stage. The TS packetizers **22**C and **23**C, by adding the packet identification information PID having values "XV2"

and "XV3" to the TS packets formed respectively, shows that the TS packets are in associated with the second and the third video data S_{VM} and S_{VH} respectively.

On the other hand, in the audio encoding unit **24**, the audio data S_A supplied is firstly entered into an audio encoder **24**A. The audio encoder **24**A encodes the input audio data S_A based on the audio encoding system described in the International Standards Regulation ITU-T Recommendation H.262 ISO/IEC13818-3, and outputs the resultant coded audio data **S30** to a packetizer **24**B. Also, the audio encoder **24**A encodes the audio data S_A per fixed number of samples that is called an audio frame, similarly to the case of video data shown in FIGS. **3**A and **3**B, and by adding a header consisting of each parameter information at the time of encoding to its head, forms ES-packetized coded audio data **S30**.

The packetizer **24**B, by connecting a fixed number of ES packets of the coded audio data **S30** encoded per audio frame and adding a PES header to the head of its packet, PES-packetizes the coded audio data **S30** and sends out the PES-packetized coded audio data **S31** to a TS packetizer **24**C.

The TS packetizer **24**C divides each PES packet of the coded audio data **S31** per 184 bytes as in the case shown in FIGS. **5**A and **5**B, and by adding a TS header of 4 bytes to each of their heads, forms a TS packet, and transmits a stream of the TS packets **S32** to the multiplexer **25** of the succeeding stage. Also in this case, the TS header consists of synchronization information and packet identification information PID. In this connection, the TS packetizer **24**C, by adding the packet identification information PID having the value "XA" to the TS packet formed, shows that the TS packet is associated with the audio data S_A.

An encoding control unit **26** provided in the transmission device **20** controls the overall operations of the video encoders **21**A to **23**A and packetizers **21**B to **23**B of the video encoding unit **21** to **23** and the audio encoder **24**A and the packetizer **24**B of the audio encoder **24**. More precisely, the encoding control unit **26** can make these circuit start all at once by transmitting a control signal **S33** to the video encoders **21**A to **23**A, the audio encoder **24**A and the packetizers **21**B to **24**B.

Furthermore, the encoding control unit **26** sets the video encoders **21**A to **23**A so that their parameters at the time of encoding become the same, using the control signal **S33**. More specifically, as shown in FIGS. **13**A to **13**C, the encoding control unit **26** sets the video encoders **21**A to **23**A so that the cycle M of P-picture and cycle N of I-picture at the time of encoding become the same, and simultaneously, so that the phases of GOPs to video data S_{VL}, S_{VM}, and S_{VH} synchronize with each other. Moreover, the encoding control unit **26** sets the GOP to be used in each of the video encoders **21**A to **23**A so that the reference relationship of pictures is completed within each GOP, that is, becomes a closed GOP. To be more precise, the closed GOP, as shown in FIGS. **13**A to **13**C, in the case of encoding B-picture placed at the head of each GOP (B-picture having the picture numbers **4** and **5** in this example), the encoding by the forward direction prediction that makes P-picture existing in the preceding other GOP as the reference picture is not conducted, but the encoding by the backward direction prediction that makes I-picture existing in the same GOP as the reference picture is conducted. Accordingly, by conducting the encoding processing in the closed GOP, if the video data S_{VL} is shifted to the video data S_{MV} at the time point t1 in the receiving device side, for example, since the reference picture exists in the same GOP, the failure in reproduced picture can be prevented in advance.

Furthermore, the encoding control unit **26**, by transmitting the control signal **S33** to the packetizers **21**B to **13**B, controls the PES packetizing processing so that the head of data part of the PES packet becomes GOP (i.e., the GOP does not cross over different PES packet), and simultaneously, the encoding control unit **26** assigns the time information PTS to the packetizers **21**B to **23**B referring to the count value of the counter (STC) **11** so that the time information PTS to be added at the time when PES packetizing become equal among the first to third video data S_{VL}, S_{VM} and S_{VH}.

In this connection, since the audio has the encoder different from that of the video, the encoding control unit **26** originally controls the audio encoder **24**A and the packetizer **24**B.

The counter (STC) **11** conducts the counting operation at 27 MHz clock CLK1, that is the reference clock for the encoding processing. The count value of this counter (STC) **11** is transmitted to a TS packetizer **27** at a fixed cycle as clock information PCR. The TS packetizer **27** successively TS-packetizes the clock information PCR transmitted at the prescribed cycle, and transmits a sequence of the TS packets **S34** to the multiplexer **25**. In this case, the TS packetizer **27**, adding the packet identification information PID having the value "XC" to the TS packet formed, shows that the TS packet is associated with the clock information PCR.

A PMT forming unit **28**A is program information forming means for forming program information PMT of lower hierarchy arranged per program, in which the program information PMT for one program consisting of the first or the third video data S_{VL}, S_{VM} and S_{VH} and the audio data S_A and the clock information PCR is formed. The program information PMT, as shown in FIG. **14**, assuming that a program number of the program is "X", the packet identification information PID of TS packet in which data comprising the program is stored, per each data. More specifically, the packet identification information PID of the TS packet in which the low angle first video data S_{VL} is stored is "XV1", and the packet identification information PID of the TS packet in which the middle angle second video data S_{VM} is stored is "XV2". Further, the packet identification information of the TS packet in which the high angle third video data S_{VH} is stored is "XV3", the packet identification information of the TS packet in which the audio data S_A is stored is "XA", and the packet identification information PID of the TS packet in which the clock information PCR is stored is "XC".

The PMT forming unit **28**A, after forming the program information PMT having such data, packetizes the information and sends out a sequence of the resultant TS packets **S35** related to the program information PMT to the multiplexer **25**. The PMT forming unit **28**A adds the packet identification information PID having the value "XX" to the TS packet formed, in order to show that the TS packet is related to the program information PMT.

The multiplexer **25** is multiplexing means, in which by sequentially selecting and outputting TS packet streams **S23**, **S26**, **S29** **S32**, **S34** and **S35** to be supplied from circuit blocks respectively in a certain order, one multiplexed transport stream **S36** for one program is formed and transmitted. Note that, buffer circuits not shown are provided in inputs of the multiplexer **25** respectively. The buffer circuits temporarily store the TS packet sequences **S23**, **S26**, **S29**, **532**, **S34**, and **S35** respectively, in order to selectively output them in a prescribed order.

In the second multiplexer **29**, transport streams **S37** to **S39** concerning the other programs formed with the same method as the transport stream **S36** are entered. Moreover, a TS packet sequence **S40** concerning the program information PAT formed at the PAT forming unit **28B** is also entered into the second multiplexer **29**.

In this case, the PAT forming unit **28B** is the program information forming means for forming the program information PAT of the higher hierarchy showing the TS packet in which program information PMT formed per program are stored, in which program information PAT on all programs to be multiplexed by the second multiplexer **29** are formed. The program information PAT are arranged according to program numbers similarly to the example shown in FIG. **7**; the packet identification information PID of the TS packet storing program information PMT on the program number "0" is "N", the packet identification information PID of the TS packet storing the program information PMT concerning the program number "1" is "A", and the packet identification information PID of the TS packet storing the program information PMT concerning the program number "X" is "XX".

The PAT forming unit **28B**, after forming the program information PAT having such data, TS-packetizes this and transmits the resultant TS packet sequence **S40** concerning the program information PAT to the second multiplexer **29**. The PAT forming unit **28B** adds the packet identification information PID having the value "0" to the TS packet formed, in order to show that the TS packet is related to the program information PAT.

The second multiplexer **29**, by successively selecting and transmitting the transport stream **S36** on the program number "X" and the transport streams **S37** to **S39** concerning the other programs and the TS packet sequence **S40** related to the program information PAT in a prescribed order, forms a transport stream **S41** obtained in by multiplexing a plurality of programs into one stream, and outputs the stream **S41** to the transmission unit **9** of the succeeding stage.

The transmission unit **9**, after forming a transmission signal by applying the modulation processing for transmitting to the transport stream **S41**, forms a transmission signal **S42** having a prescribed band by applying a frequency conversion processing to the transmission signal, and transmits the signal **S42** toward the satellite (not shown) via an antenna **10**.

Then, the receiving device of the digital broadcasting system for receiving the transmission signal **S42** will be described referring to FIG. **15**. The transmission signal **S42** relayed via the satellite is received by an antenna **31** of the receiving device **30** shown in FIG. **15**, and the received signal **S50** is supplied into the receiving unit **32**. The receiving unit **32**, by applying the frequency conversion processing and the demodulation processing to the received signal **S50**, restores a transport stream **S51** to be transmitted from the transmission device **20** and sends this out to a demultiplexer **33** and a control unit **34**.

The control unit **34** identifies the packet identification information PID of each of the TS packets included in the transport stream **S51**, and outputs a control signal **S52** based on the packet identification information PID to control the selecting operation of the demultiplexer **33**. Thereby, the desired TS packet is extracted from the transport stream **S51**.

More specifically, the control unit **34** makes the demultiplexer **33** extract the TS packet having the packet identification information PID value "0" and take out the TS packet **S53** of the program information PAT. The TS packet **S53** of the program information PAT is sent to the PAT storage unit **35**. The PAT storage unit **35** analyzes the TS packet **S53** and stores program information included in it in the internal memory area.

Under such conditions, at the time of requesting a desired program from the user with the operation unit **36**, the control unit **34** firstly refers to the program information PAT stored in the PAT storage unit **35** based on the request. Then, the control unit **34** obtains the packet identification information PID of the TS packet storing the program information PMT of the requested program, and making the demultiplexer **33** extract the TS packet based on that packet identification information PID, in order to extract the TS packet **S54** including program information PMT of the requested program. The TS packet **S54** of the program information PMT is sent to the PMT storage unit **37**.

The PMT storage unit **37** analyzes the TS packet **S54** and stores the program information PMT included in the TS packet in the internal memory area. The control unit **34** obtains the packet identification information PID storing data forming the requested at program referring to the program information PMT stored in this PMT storage unit **37**. In this case, a plurality of video data exist per one program and the packet identification information PID related to the video data S_{VM} is obtained from the PMT storage unit **37** as the initial value.

The control unit **34** makes the demultiplexer **33** extract the TS packet based on the packet identification information PID obtained, in order to extract TS packets **S55** to **S57** storing video data S_{VM}, audio data S_A and clock information PCR of the requested program respectively. Out of the TS packets extracted, the TS packet **S55** related to the video data S_{VM} is transmitted to a video decoding unit **38** and the TS packet **S56** related to the audio data S_A is sent out to an audio decoding unit **39**, and the TS packet **S57** related to the clock information PCR is transmitted to a counter (STC) **15**.

The counter (STC) **15** takes out clock information PCR included in the TS packet **S57** and sets this as the initial value of the counter and starts the counting operation based on 27 MHz clock CLK2. The phase-locked loop (PLL) **16** obtains the difference between the clock information PCR included in the TS packet **S57** to be transmitted at the fixed intervals and the count value of the counter (STC) **15**, and by controlling the clock generator **14** based on the difference, generates a clock CLK2 synchronized with the clock CLK1 of the transmission device **20**, in order to synchronize the counting operation of the counter (STC) **15** with the counter (STC) **11** of the transmission device **20**. Thus, the count value of the counter (STC) **15** synchronized with the transmitting side is sent out to a decoding control unit **40** for controlling the reproduction output timing.

The video decoding unit **38** firstly enters a TS packet **S55** on the video to be supplied, into an internal ES streamizer **38A**. The ES streamizer **38A** restores the PES data by connecting the video data to be supplied after being TS-packetized, and further converts the PES data to an elementary stream **S58** per coding unit and outputs the elementary stream **S58** related to the video to the video decoder **38B**. Moreover, the ES streamizer **38A** takes out the time information PTS concerning the video included in the PES data when converting the TS packet **S55** into the PES data, and outputs this to the decoding control unit **40** as a time signal **S59**.

The video decoder **38B** starts the decoding processing for the elementary stream **S58** based on the timing information **S60** supplied from the decoding control unit **40**, and sends

out the resultant restored video data **S61** to the television receiver (not shown) of the succeeding stage.

Similarly, at first, the audio decoding unit **39** supplies the TS packet **S56** concerning audio supplied, to the internal ES streamizer **39A**. The ES streamizer **39A** restores the PES data by connecting audio data to be transmitted after being TS-packetized, further converts the PES data into an elementary stream **S62** per the coding unit, and outputs the elementary stream **S62** concerning the audio to the audio decoder **39B**. Moreover, the ES streamizer **39A** takes out the time information PTS concerning audio included in the PES data at the time of converting the TS packet **S56** into the PES data, and outputs this to the decoding control unit **40** as a time signal **S63**.

The audio decoder **39B** starts the decoding processing for the elementary stream **S62** based on the timing information **S66** supplied from the decoding control unit **40**, and outputs the resultant restored audio data **S64** to the television receiver of the succeeding stage.

The decoding control unit **40** judges whether timing of the time information PTS shown by time signals **S59** and **S63** have come or not, based on the time signals **S59** and **S63** concerning video and audio and the count value of the counter (STC) **15**. When it judges that timing has come, the timing information **S60** is transmitted to control the decoding start of the video decoder **38B** and the audio decoder **39B**.

Accordingly, the receiving device **30** obtains the program information PMT of the program requested by the user, referring to the program information PAT and then, referring to the program information PMT, takes out the TS packet of data forming the requested program and restores video and audio data **S61** and **S64** of the program.

By the way, a plurality of associated video data S_{VL}, S_{VM} and S_{VH} are transmitted from the transmission device **20** for one program. In the aforementioned explanation, the video data S_{VM} is selected as the initial value, however, in the case where the user requests to switch to the other video data S_{VL} or S_{VH}, these video data can be shifted easily.

For example, in the case where a request to switch to the video data S_{VH} is entered with the operation unit **36**, the control unit **34** obtains the packet identification PID of the TS packet storing the video data S_{VH}, referring to the program information PMT stored in the PMT storage unit **37**, based on the request. The control unit **34** makes the demultiplexer **33** extract the TS packet based on the packet identification information PID to take out the TS packet of the video data S_{VH}. The TS packet **S54** extracted is sent to the video decoding unit **38** to be decoded, and is transmitted as video data **S61**. Thus, it can easily switch to the video data S_{VH} requested.

In this connection, in the case of switching the TS packet to be extracted at the demultiplexer **33**, the control unit **34** switches it at the timing of the following PES data. In this case, as well as matching the head of PES data of each video data S_{VL}, S_{VM} and S_{VH} to the head of GOP, the phases of GOPs of video data S_{VL}, S_{VM} and S_{VH} Synchronize with each other. Furthermore, since individual GOP is set to the closed GOP, data failure never occurs in the reproduced picture even though it is switched to another video data. Moreover, since time information PTS and clock information PCR are available in he same program, even when it is shifted to another video data, the phase of the reproduced picture can be prevented from shifting and the continuity of the reproduced picture can be maintained.

According to the foregoing construction, the transmission device **20** of the digital broadcasting system TS-packetizes and transmits a plurality of associated video data S_{VL}, S_{VM} and S_{VH}. In this case, the transmission device **20**, adding different identification information PID to the TS packet of each of the video data S_{VL}, S_{VM} and S_{VH}, transmits them. Moreover, the transmission device **20** forms the program information PMT to control the associated video data S_{VL}, S_{VM} and S_{VH} as one program, and also TS-packetizes and transmits the program information PMT. Moreover, in the transmission device **20**, the program information PAT of the higher rank to show the TS packet storing the program information PMT of the program is also TS-packetized and transmitted.

Accordingly, in the transmission device **20**, TS-packetized video data and program information PMT and PAT of each program are finally multiplexed to one transport stream **S41** and transmitted to the receiving device **30** through the satellite wireless circuit. In the receiving device **30**, firstly, the program information PAT of the higher rank is received, and referring to the program information PAT, the TS packet storing the program information PMT of the program requested by the user is received to obtain the program information PMT of the program requested by the user. And the receiving device **30**, referring to the program information PMT, receives the TS packet of the middle angle second video data S_{VM} that is set as the initial value, and conducting the decoding processing, outputs the second video data S_{VM}.

Under such conditions, if a command to switch to another video data S_{VL} or S_{VH} is entered by the user, the receiving device **30** receives the TS packet of the requested video data S_{VL} or S_{VH} referring to the program information PMT stored in the PMT storage unit **37** and decoding this, in order to output the requested video data S_{VL} or S_{VH}.

In the case of this digital broadcasting system, a plurality of associated video data S_{VL}, S_{VM} and S_{VH} are TS-packetized and transmitted respectively and simultaneously, the program information PMT to control the plurality of associated video data S_{VL}, S_{VM} and S_{VH} as one program is TS-packetized and transmitted, so that the receiving side can easily switch the video data S_{VL}, S_{VM} and S_{VH} referring to the program information PMT, once the receiving side receives the program information PMT. In the case where associated video data S_{VL}, S_{VM} and S_{VH} are transmitted as separate programs as before, it is necessary to get the program information PMT whenever switching video data because the program information PMT is formed per program. Accordingly, there was that the processing of the receiving side became complicated. However, if the program information PMT to control the associated video data S_{VL}, S_{VM} and S_{VH} as one program is transmitted, all packet identification information PID of the associated video data S_{VL}, S_{VM} and S_{VH} can be grasped and thus, such problem can be solved.

Furthermore, in the case of encoding the plurality of associated video data S_{VL}, S_{VM} and S_{VH}, the encoding processing to synchronize the coding unit at the time of encoding between these video data S_{VL}, S_{VM} and S_{VH} within the coding unit is conducted, so that the failure of the reproduced picture when switching the video data S_{VL}, S_{VM} and S_{VH} can be prevented.

Furthermore, in the case of encoding the associated video data S_{VL}, S_{VM} and S_{VH}, the timing information PTS to regulate the timing at the time of reproduction-output are to become equal among the video data S_{VL}, S_{VM} and S_{VH}, the phase of the reproduced picture can be prevented from shifting when switching the video data S_{VL}, S_{VM} and S_{VH} and the continuity of the reproduced picture can be maintained.

According to the foregoing construction, since a plurality of associated video data S_{VL}, S_{VM} and S_{VH} are TS-packetized and transmitted, and simultaneously, the program information PMT to control the plurality of associated video data S_{VL}, S_{VM} and S_{VH} as one program is TS-packetized and transmitted. Thereby, a plurality of video data S_{VL}, S_{VM} and S_{VH} associated with one program can be easily transmitted without conducting a complicated processing.

Note that, in the aforementioned embodiment, a plurality of associated video data S_{VL}, S_{VM} and S_{VH} is transmitted as one program. However, the present invention is not only limited thereto and a plurality of associated audio data can be transmitted as one program. In the case of transmitting the plurality of associated audio data as one program, similarly to the case of the video data, a plurality of associated audio data is encoded and TS-packetized respectively, TS packets of the plurality of associated audio data are multiplexed and transmitted, and program information PMT to control the associated audio data as one program is TS-packetized and transmitted. Thereby, the same effects as those of the video data can be obtained.

Moreover, in the aforementioned embodiment, an account method is not described. However, video data S_{VL}, S_{VM} and S_{VH} are scrambled using a secret key respectively, and the receiving side removes the scramble using the secret key corresponding to the received video data, so that fee can be charged per each secret key used. With this arrangement, the fee can be charged per video data even though video data are the same one program. Moreover, fee can be charged per program by applying the scramble to video data S_{VL}, S_{VM} and S_{VH} using the same secret key.

Furthermore, in the embodiment described above, the video data S_{VM} out of associated video data S_{VL}, S_{VM} and S_{VH} is reproduced and outputted as the initial value. However, the present invention is not only limited thereto and another video data S_{VL} or S_{VH} can be transmitted as the initial value.

Furthermore, in the embodiment described above, video data S_{VL}, S_{VM} and S_{VH} each having the different photographic direction are transmitted as the associated video data. However, the present invention is not only limited thereto and main video data, and sub video data to provide supplemental remarks to the main video data, such as by the sign language can be transmitted. Thereby, the same effects as those of the above can be obtained.

Moreover, in the embodiment described above, the transport stream **S41** formed finally is transmitted through the satellite wireless circuit. However, the present invention is not only limited thereto this and a transport stream can be transmitted through a terrestrial wireless circuit and a cable circuit. In short, the present invention can be widely applied as long as the transmission device transmits a finally formed transport stream through a prescribed transmission path.

According to the present invention as described above, in the case of transmitting a plurality of associated video data, the first program information to control the plurality of associated video data as one program is formed and transmitted, so that a plurality of video data associated with one program can be transmitted without a complicated processing at the time of reception.

While there has been described in connection with the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be aimed, therefore, to cover in the appended claims all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A video transmission device comprising:

a plurality of video encoding means for encoding a plurality of associated video data and for adding different packet identification information to the coded video data respectively to packetize and output them;

program information forming means, in order to control said plurality of associated video data as one program, for forming first program information to show said packet identification information, which are added to said coded video data respectively, per video data and for adding proper packet identification information to the first program information to packetize and output it;

first multiplexing means for multiplexing packets concerning each of video data to be transmitted from said plurality of video encoding means onto packets of said first program information to be transmitted from said program information forming means, and for outputting first transmission data for one program;

second multiplexing means for multiplexing said first transmission data to be transmitted from said first multiplexing means and second transmission data formed of another program onto second program information showing said packet identification information, which is added to said first program information of each program to be transmitted, per program, and for outputting third transmission data; and

transmission means for transmitting said third transmission data to be transmitted from said second multiplexing means through a prescribed circuit.

2. The video transmission device according to claim **1**, further comprising

a plurality of audio encoding means for encoding a plurality of associated audio data and for adding different packet identification to the coded audio data respectively to packetize and output them; wherein

said program information forming means, as well as showing said packet identification information, which are added to said coded video data respectively, per video data, forms said first program information showing said packet identification information, which are added to said coded audio data respectively, per audio data.

3. The video transmission device according to claim **1**, wherein

said plurality of video encoding means, as well as encoding video data so that coding units synchronize between the video data, applies such an encoding as finishes within the coding unit, to said video data.

4. The video transmission device according to claim **1**, wherein

said plurality of video encoding means, as well as adding time information to regulate a processing timing at a decoding side, to each of said coded video data, makes the time information to be equal among the video data.

5. A video transmission method, comprising the steps of:

as well as encoding a plurality of associated video data, adding different packet identification information to the coded video data respectively to packetize them;

in order to control said plurality of associated video data as one program, forming first program information to show said packet identification information, which are added to said coded video data respectively, per video data and adding proper packet identification information to the first program information to packetize it;

forming first transmission data for one program by multiplexing packets concerning said video data onto packets for said first program information; and

forming third transmission data by multiplexing said first transmission data, second transmission data formed of another program onto second program information showing said packet identification information, which is added to said first program information of each program to be transmitted, per program, and transmitting the third transmission data through a prescribed circuit.

6. The video transmission method according to claim **5**, wherein:

a plurality of associated audio data is encoded, and different packet identification information are added to coded audio data respectively to packetize the coded audio data; and

said packet identification information, which are added to said coded video data respectively, are showed per video data, and said first program information showing said packet identification information, which are added to said coded audio data respectively, per audio data is formed.

7. The video transmission method according to claim **5**, wherein

encoding is applied to video data so that coding units synchronize between the video data, and such an encoding as finishes within the coding unit is applied to said video data to respectively.

8. The video transmission method according to claim **5**, wherein

in the case of encoding said video data, time information to regulate a processing timing of a decoding side is added to each of said coded video data, and the time information is to be equal among the video data.

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